CsI Calorimeter Status Report

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- ❑ Calorimeter Science Requirements
- ❑ Calorimeter Electronics Design Review
- ❑ Mechanical Design Issues

Calorimeter Science Requirements

June 1 meeting prior to electronics review, chaired by Steve Ritz

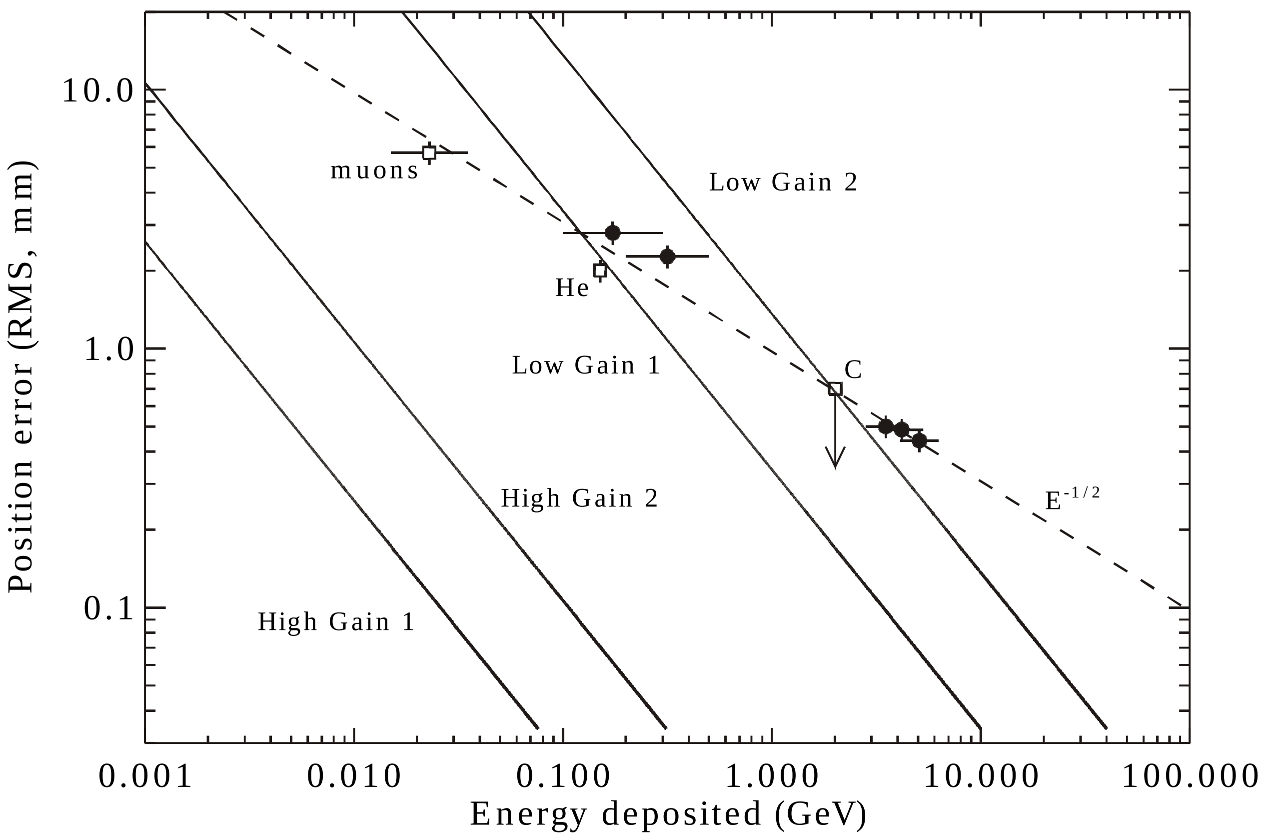
- Issue 1 - energy range, energy resolution for
  - Top entering gamma's
    - current electronics saturate for 40 GeV in a single CsI block - OK when GLAST's top energy was 100 GeV but is inadequate for goal of 300 GeV
    - modest energy resolution required for spectral modeling of AGN w/ breaks, ie. Featureless continua. Resolution requirement ~ 20%.
  - Side entering electrons (~TeV)
    - can get up to 500 GeV in a single CsI block!
    - Featureless continua, energy resolution of ~ 20% adequate
  - Side entering gamma-ray <u>lines</u> up to 300 GeV
    - line features are extremely narrow, sensitivity goes as ~ sqrt of energy resolution. 1 - 2% energy resolution is goal.
    - Peak energy in single crystal up to 100 GeV
- Issue 2 - support for gamma ray bursts
  - max event rate
  - spectroscopic measurements near 1 MeV

Prototype ASIC Shaping Amps

- Two shaper gains per PIN diode and preamp (3 usec peaking)
  - Differ in gain by approximately x4.
  - Used to improve quantization error with 12-bit ADCs and to reduce dynamic range requirement for peak detect and hold.
- One fast shaper (0.4 μsec peaking) per PIN

	High Gain X4	High Gain Full	Low Gain X4	Low Gain Full	Low Gain Fast Shaping
Max Energy	80 MeV	320 MeV	10.24 GeV	40.96 GeV	40.96 GeV
Chan Width	0.019 MeV	0.078 MeV	2.5 MeV	10 MeV	n/a
Threshold	1 MeV	80 MeV	300 MeV	10 GeV	~ 1 GeV
Noise Estimate (Simulation)	1500 e^- rms (0.15 MeV)	1200 e^- rms (0.12 MeV)	13,500 e^- rms (5.4 MeV)	8000 e^- rms (3.2 MeV)	2×10^5 e^- rms (80 MeV)
Quantization Error @ Thresh	2%	0.1%	0.8%	0.1%	n/a
Chan # of 1 MIP	668/4096	162/4096	5/4096	0	n/a
Chan # of ^{12}C	**	**	183/4096	46/4096	(~9 × noise)

ADC Quantization Error
Prototype ASIC

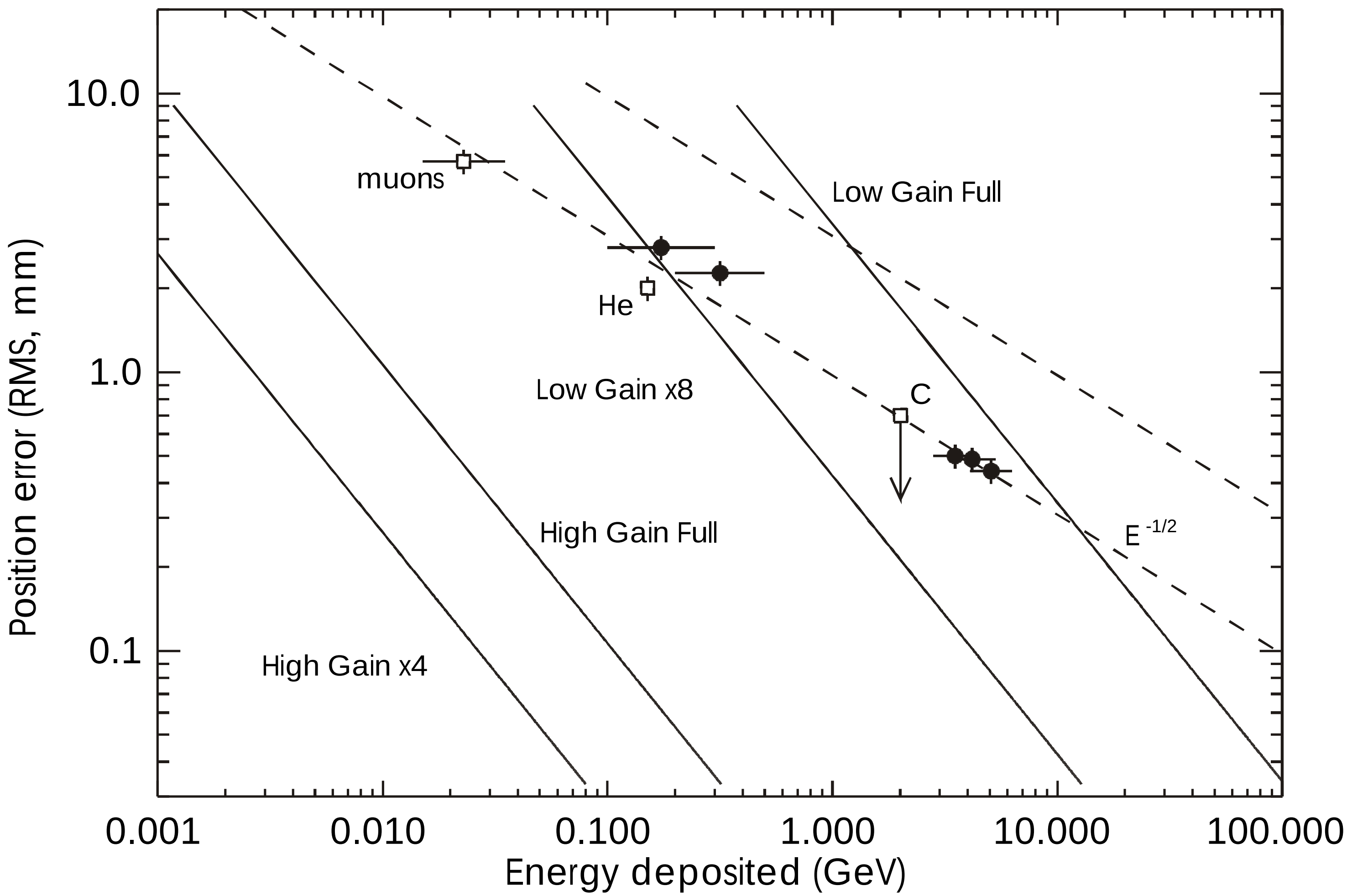


Alternate Gain Scales
Max Range 100 GeV

- High Energy Range
  - Reduce size of PIN by additional factor of 2 - 2.5 (~10% of larger PIN).
  - Increase gain ratio of shapers to x8.
- Low Energy Range - unchanged

	High Gain X4	High Gain Full	Low Gain X8	Low Gain Full
Max Energy	80 MeV	320 MeV	12.8 GeV	102 GeV
Chan Width	0.019 MeV	0.078 MeV	3.1 MeV	25 MeV
Threshold	1 MeV	80 MeV	300 MeV	12 GeV
Noise Estimate (Simulation)	1500 e^- rms (0.15 MeV)	1200 e^- rms (0.12 MeV)	Need Simulation	Need Simulation
Quantization Error @ Thresh	2%	0.1%	1%	0.2%
Chan # of 1 MIP	648/4096	162/4096	4/4096	0
Chan # of ^{12}C	**	**	145/4096	18/4096

Alternate Gain Scale
Max Range 100 GeV



Calorimeter Support for Gamma Ray Bursts

- ❑ Current design considerations
  - Provides threshold rates for potential burst detection processing and temporal studies in the > 1 MeV energy band.
  - Spectroscopic studies of bursts limited to GRB photons which initiate GLAST L1 trigger via tracker or calorimeter information
- ❑ Improved capability - spectroscopy in calorimeter > 1MeV, using all or top layers of calorimeter.
  - Self triggering of the calorimeter at threshold (~1 MeV) is already a test mode and likely could be operational mode, but..
    - – What is this trigger rate?
    - – What does GLAST do, if the calorimeter is busy digitizing 1MeV background γ's when GeV tracker event occurs? ie. Deadtime, operational mode impacts?

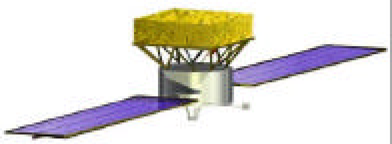
Calorimeter Electronics Review
ASIC Review Committee

Committee Membership

Bill Atwood, SLAC (chair)
Jim Ampe, NRL
Bob, Baker, GSFC
Chuck Britton, ORNL
Brenda Dingus, Utah
David Dorfan, UCSC
Oren Milgrome, LBL
Scott Williams, Stanford (sec’y)

Charge to the Committee

- Review the GLAST calorimeter electronics concept and specifications and determine its ability to meet the requirements.
- Review the design of the calorimeter prototype front-end ASIC, in particular the technology used, design margins, radiation hardness, robustness and efficiency of design.
- Review the future program of the GLAST calorimeter electronics.



Calorimeter Electronics Review
Preliminary Summary Findings

- ❑ The choice of HP 0.5 μm CMOS process was not well advised.
  - The current design requires running the ASIC at considerably higher rail voltages than for which the process is designed (3.5 V spec versus design voltage of 5 V).
  - Over-voltaging a process often leads to premature component failure and radiation susceptibility.
- ❑ The preparation for testing the prototype chips was found to be inadequate and compromised the ability of the experts on the review panel to evaluate the design's actual performance.
- ❑ The overall level of communication between the physicists and the engineers seemed to be minimal and should be improved.
- ❑ In light of current progress, the schedule as presented to support beamtest '99 is unrealistic, particularly if the design is migrated to a new process.
  - Essentially none of the digital / DAC elements have been designed and are essential at the systems level.

Calorimeter Electronics Review
Preliminary Recommendations

- The CsI calorimeter development is severely compromised by lack of resources. Must add
  - Personnel
    - PCB layout designer
    - Digital ASIC EE designer
    - EE/Physicist for testing (also design analog/digital test configuration)
    - Appropriate technician support
    - GLAST systems engineer at GSFC
  - Upgrade modeling tools (get 1.2 um specifications from UCSC, LBL, Lick Observatory)
  - Adequate $s for
    - Test equipment
    - Chip fab runs - one additional run at $6k for fab, additional $s for testing

Calorimeter Electronics Review
Preliminary Recommendations (cont)

- ❑ Revise schedule for prototype tower
  - Explore “farming-out” some fab testing
  - Descope functionality of front-end
  - Develop fall back position if personnel/resources allow (i.e. use existing 0.5 um chip)
- ❑ Schedule a Burster session at June GLAST team meeting
  - Time profile of events, rates and spectrum to design to.
- ❑ Next review
  - Make available full design layout details before review (send current generated GDS file via e-mail to Hartmut Sadrozinski and Chuck Britton)
- ❑ Next review 12/98, prior to flight submission, after detailed testing on 1.2 um chips is well underway.

Calorimeter Electronics Review
Subsystem Manager's Comments

- The results of inadequate resources in the calorimeter development were painfully obvious to everyone. To date, the effort is supported only by NASA/DOD funding at a level that has limited progress.
- The options for recovery from the HP 0.5 μm, 5 Volt design are being vigorously pursued.
- The apparent disorganization of the test program was more a failure to present a coherent statement of the program.
  - The lack of quality test results was lack of test time - engineers were still debugging test environment and tools.
  - Preparation for testing should have been better.
  - Testing has continued and understanding of the ASIC and its performance is improving.
- Better communications is always better.

Calorimeter Mechanical Design

- As part of the development program, SLAC is supporting the development of the Hytec design for the calorimeter (Z-axis compression, X-Y frictional stability)
  - Detail design by Hytec
  - NRL providing CsI samples for key vibration testing at Hytec
  - CsI wrapping characteristics critical for success of friction concept.
- CsI crystals for Beamtest ‘99
  - SLAC and Stanford have taken over responsibility for the procurement (and the expense).
  - There is some chance that these crystals may be provided by a State Dept. program - Science & Technology Center in the Ukraine. Decision may be too late to help for beam test.

Hytec Concept #2